

AD-A111 875

BOEING AEROSPACE CO SEATTLE WA

F/S 17/2.1

PRESTO DIGITAL COMPUTER CODE USER'S GUIDE. VOLUME 1. SYSTEM OVE--ETC(U)

OCT 80

DNA001-78-C-0271

UNCLASSIFIED

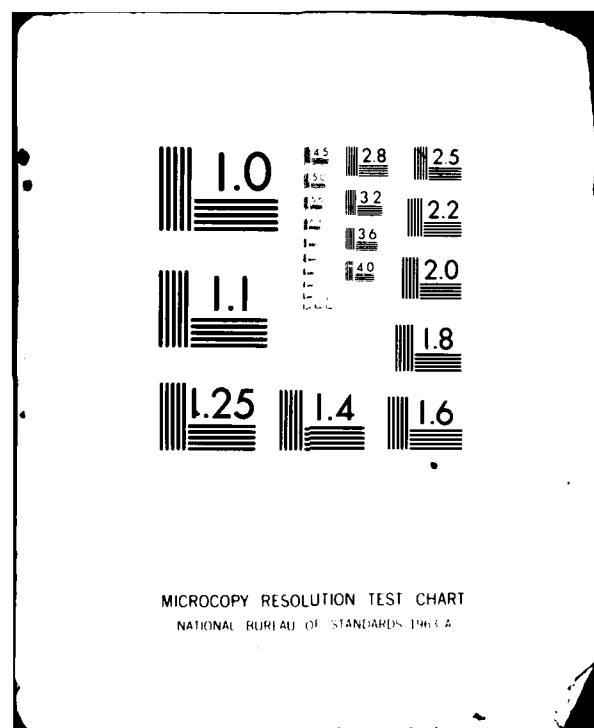
SBI-AD-E300 936

NL

100 1
200 2
300 3



END
DATE
FILMED
4-82
DTIC



(12)

DNA 3898F-1

Revision A

PRESTO DIGITAL COMPUTER CODE USER'S GUIDE

Volume I - System Overview

Boeing Aerospace Company
P.O. Box 3999
Seattle, Washington 98124

31 October 1980

Final Report for Period 1 May 1978—31 October 1980

CONTRACT No. DNA 001-78-C-0271

APPROVED FOR PUBLIC RELEASE;
DISTRIBUTION UNLIMITED.

THIS WORK SPONSORED BY THE DEFENSE NUCLEAR AGENCY
UNDER RDT&E RMSS CODES B363080464 O99QAXCE50201 H2590D
AND B363080464 O99QAXCE50202 H2590D.

Prepared for
Director
DEFENSE NUCLEAR AGENCY
Washington, D. C. 20305

DTIC
ELECTE
MAR 11 1982
S A D

82 02 16 189

ADA111875

Destroy this report when it is no longer
needed. Do not return to sender.

PLEASE NOTIFY THE DEFENSE NUCLEAR AGENCY,
ATTN: STTI, WASHINGTON, D.C. 20305, IF
YOUR ADDRESS IS INCORRECT, IF YOU WISH TO
BE DELETED FROM THE DISTRIBUTION LIST, OR
IF THE ADDRESSEE IS NO LONGER EMPLOYED BY
YOUR ORGANIZATION.



UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER DNA 3898F-1, Rev. A	2. GOVT ACCESSION NO. 66-A111 875	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) PRESTO DIGITAL COMPUTER CODE USER'S GUIDE Volume I—System Overview		5. TYPE OF REPORT & PERIOD COVERED Final Report for Period 1 May 78—31 Oct 80
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) V&H Engineering Staff		8. CONTRACT OR GRANT NUMBER(s) DNA 001-78-C-0271
9. PERFORMING ORGANIZATION NAME AND ADDRESS Boeing Aerospace Company P.O. Box 3999 Seattle, Washington 98124		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS Subtasks 099QAXCE502-01 099QAXCE502-02
11. CONTROLLING OFFICE NAME AND ADDRESS Director Defense Nuclear Agency Washington, D.C. 20305		12. REPORT DATE 31 October 1980
		13. NUMBER OF PAGES 34
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)		15. SECURITY CLASS. (of this report) UNCLASSIFIED
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE N/A
16. DISTRIBUTION STATEMENT (of this Report) Approved for public release; distribution unlimited.		
17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)		
18. SUPPLEMENTARY NOTES This work sponsored by the Defense Nuclear Agency under RDT&E RMSS Codes B363080464 099QAXCE50201 H2590D and B363080464 099QAXCE50202 H2590D		
19. KEY WORDS (Continue on reverse side if necessary and identify by block number) Circuit Analysis Display Codes Systems Analysis Computer Aided Analysis Executive Transfer Function Computer Code Interface Codes EMP Control Language Modeling		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) PRESTO, an integrated system of computer codes, has been developed for the PREMPT program to perform EMP response analysis of communications systems. Volume One of the PRESTO User's Guide presents an overview of the entire PRESTO system and an introduction to the material contained in the other volumes (two through six) of the PRESTO User's Guide series.		

DD FORM 1473
1 JAN 73

EDITION OF 1 NOV 65 IS OBSOLETE

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE(When Data Entered)



UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE(When Data Entered)

SUMMARY

The PRESTO system of computer codes provides engineering users with a tool for expeditiously analyzing electronic systems to determine electromagnetic pulse (EMP) effects. It is expected that the users will have a basic knowledge of digital computer usage, including the FORTRAN language. It is also expected that users will have basic knowledge of conducting survivability/vulnerability assessments.

A
A
A

PRESTO consists of three groups of codes: an executive code, application codes, and a modeling library. The executive code provides the interface between the engineering user and the application programs which perform the calculations requested by the user. The modeling library contains subroutines used to model the electromagnetic response of signal cables, power systems, and ground systems.

The PRESTO code interprets the user input, performs the required computation, and generates the output specified by the user.

A modular approach is utilized in PRESTO to achieve maximum flexibility. The modularity of PRESTO and the independence of the executive control program facilitates the incorporation of additional application codes and modeling libraries applicable to system analyses other than for EMP effects, e.g., EMI, EMC, lightning, radiation effects, structures, flight dynamics, hydraulics, and control systems.

A
A

Rev. A

1



DTIC	
COPY	
INSPECTED	
2	
BY	
Distribution	
Approved for	
Aval for	
Dist	
Special	
A	

PREFACE

This document presents a System Overview of the PRESTO Digital Computer Code User's Guide. The document is Volume One of the six volumes which make up the guide. Volumes Two through Six have a limited distribution. Readers having an interest in or need for Volumes Two, Three, Five or Six should address a request to:

Headquarters
Defense Nuclear Agency
Attention: RAEE
Washington, D.C. 20305

Similarly, readers having an interest in or need for Volume Four should address a request to:

Mr. M. A. Espig
General Electric Tempo
P.O. Drawer QQ
Santa Barbara, California 93102

The results should fully identify requirements and/or potential applications.

Revisions of Volumes One, Two, Three, Five and Six will be published periodically. A summary of each revision is listed on the Revision page located at the end of each volume. The page and paragraph changes are identified by the revision letter in the right margin adjacent to the change and in the lower left corner of the page. Volume pagination is indicated by the Active Sheet Record in front of the Revision page.

TABLE OF CONTENTS

<u>Section</u>	<u>Page</u>
SUMMARY	1
PREFACE	2
LIST OF ILLUSTRATIONS	4
1.0 INTRODUCTION	5
1.1 PURPOSE AND SCOPE	5
1.2 BACKGROUND	6
1.3 APPROACH	6
2.0 PRESTO	11
2.1 EXECUTIVE CODE	11
2.2 APPLICATION CODES	13
2.3 TRAFFIC MODELING LIBRARY	18
3.0 PRESTO CODE NUMERICAL ACCURACY	19
4.0 PROBLEM SIZE CAPABILITY	21
5.0 PRESTO INPUT	22
6.0 PRESTO OUTPUT	24
7.0 CONCLUSIONS	25

LIST OF ILLUSTRATIONS

<u>Figure</u>		<u>Page</u>
1.3-1	Facility response prediction methodology	8
1.3-2	PRESTO system	10
2.0-1	Example of PRESTO processing flow	12
2.1-1	Interrelation of PRESTO codes	14
5.0-1	Typical PRESTO data deck structure	23

A

Rev. A

1.0 INTRODUCTION

1.1 PURPOSE AND SCOPE

The purpose of the PRESTO User's Guide is to provide a tool to be used in the conduct of survivability/vulnerability assessments.

A
A

The PRESTO User's Guide consists of six volumes and is organized as follows:

Volume One	System Overview
Volume Two	Executive Code (ESCORT)
Volume Three	Frequency Domain Analysis Code (TRAFFIC)
Volume Four	*CIRCUS-2
Volume Five	Interface and Display Codes
Volume Six	Modeling Library

This document, Volume One, presents a system overview of the PRESTO integrated system of computer codes. The PRESTO system was developed to provide engineering users with a tool for analyzing electronic systems to determine electromagnetic pulse (EMP) effects. It is expected that the users will have a basic knowledge of digital computer usage, including the FORTRAN computer language.

Section 1.0 of this document provides the purpose and scope, background and the PRESTO system approach to facility response predictions. Section 2.0 provides an overview of the PRESTO code. The numerical accuracy of the code is discussed in Section 3.0, and problem size capability is reviewed in Section 4.0. PRESTO inputs and outputs, both data and control, are discussed in Sections 5.0 and 6.0, respectively; conclusions are provided in Section 7.0.

A

* Volume Four was released June 1973 by Harry Diamond Laboratories as Report Number 0062-1.

1.2 BACKGROUND

The development of the EMP analysis codes was initiated under government funding in 1969 by The Boeing Company for use in support of the Minuteman In-Place EMP program. During 1969 through 1973, two numerical analysis codes were developed, i.e., TRAFFIC, for use in analyzing circuits in the frequency domain, and CIRCUS-2, for analyzing circuits in the time domain. Also developed during this period were time-to-frequency domain transforms, frequency-to-time domain transforms, a capability for representing frequency domain equivalent circuits in the time domain, and a library of modeling subroutines.

In 1973 the Defense Nuclear Agency (DNA) funded an effort to integrate the EMP analysis codes into a system of analysis tools the engineer could use with a minimal knowledge of computers or programming. Two criteria were emphasized in the development effort: 1) ease of use by the engineer, and 2) applicability of the codes to a general class of systems analysis problems. As a result of this criteria, much of the work completed on PRESTO since 1973 has been to modify codes developed on the Minuteman program to include more generalized capabilities. Consequently, the PRESTO system has become more user-oriented through development and documentation of a control program, user languages, standard storage and retrieval systems, and a generalized output package.

1.3 APPROACH

PRESTO was developed to perform the computations necessary to predict the functional response of communication facilities subjected to an EMP environment. To accomplish this, PRESTO calculates the EMP coupling to cables and equipment in a facility, compares the calculated induced waveform characteristics with component thresholds, and provides parameters defining the functional response of the facility.

The method of predicting the facility EMP functional response is outlined in Figure 1.3-1 and consists of three elements: 1) electromagnetic analysis, 2) functional analysis, and 3) response analysis. The first element, electromagnetic analysis, results in a definition of the coupling from the EMP environment to the components. As a starting point for the electromagnetic analysis, a facility description is required which defines the collectors of electromagnetic energy, the electromagnetic characteristics of the facility structure, and the electromagnetic coupling paths from the collectors to susceptible components. The electromagnetic response model is a detailed electrical analog of the coupling from the EMP environment to the component terminals.

The second element, functional analysis, culminates in a characterization of the effect of component disruption on facility operation. For this element, a functional description of the facility equipment and equipment interconnection is required. From this description, components critical to the facility operational performance are identified, upset and damage threshold characteristics of the components are determined, and a functional response model, which provides a quantitative relationship between the component disruptions and the functional responses within the facility, is developed. A

The third element, response analysis, combines the results from the electromagnetic and functional analyses with the EMP environment to predict the facility response. The response analysis is performed with the PRESTO computer code, which calculates the EMP-induced waveforms at components and expected component disruption. The resulting facility functional response caused by the component disruptions can then be determined. The input to PRESTO consists of the electromagnetic response model, the functional response model, component thresholds, an EMP environment specification, and analysis controls for sequencing the computations. Once the electromagnetic response model and the functional response model are constructed, the versatility of PRESTO allows for assessment of a facility to any EMP scenario by changing the EMP environment specification. A A

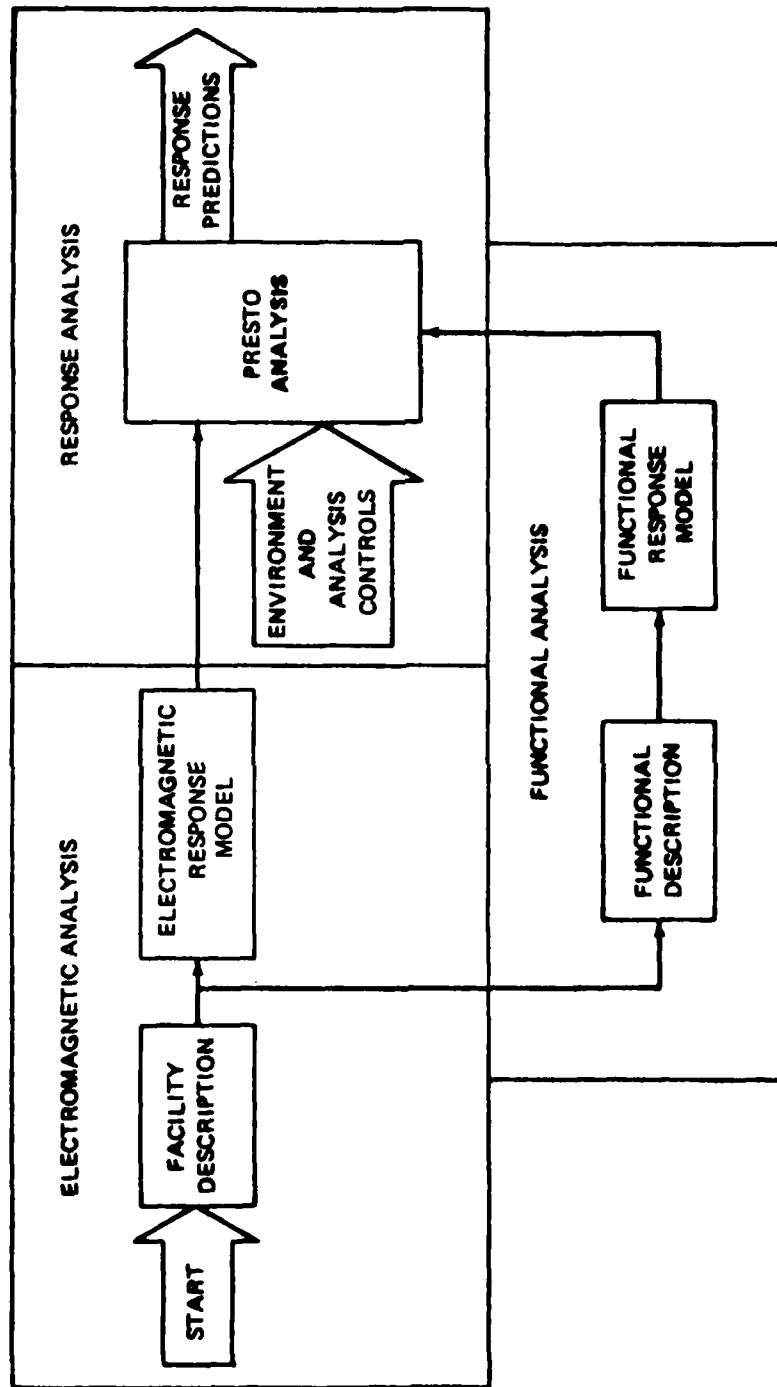


Figure 1.3-1. Facility response prediction methodology.

PRESTO consists of a modeling library for electromagnetic and functional responses, a control program, and codes for analysis and assessment calculations. The output from PRESTO consists of plots of waveforms, spectra, impedances, etc., tabulated listings of models and results, PRESTO reports of component responses, facility functional responses, files, and errors. The flow from input to output is summarized in Figure 1.3-2.

A

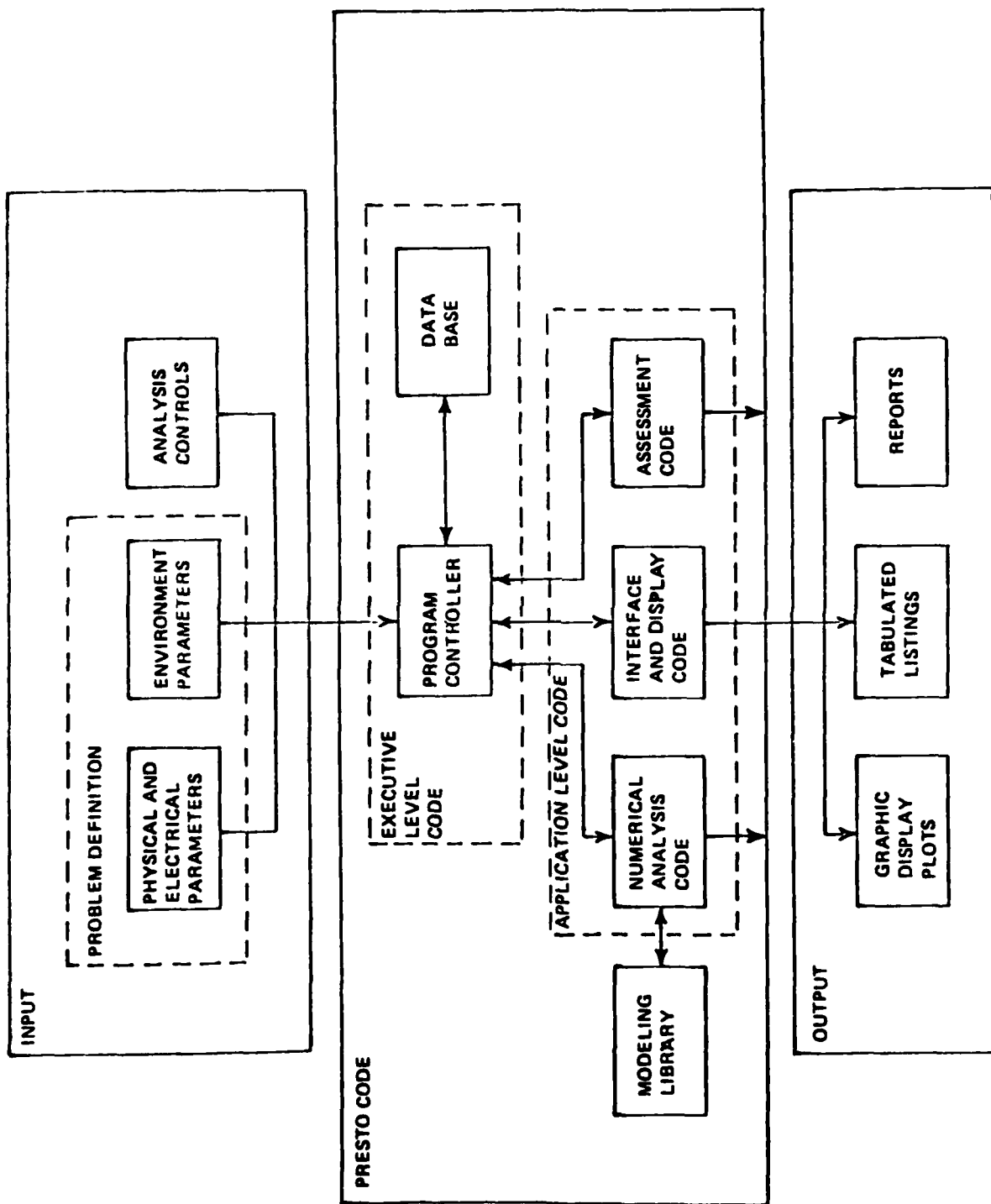


Figure 1.3-2. PRESTO system.

A
↓

2.0 PRESTO

The PRESTO system of computer codes is a collection of independent application programs and modeling libraries which are linked by an executive control program into an integrated system to solve system analysis problems.

PRESTO consists of three groups of codes: an executive code, application codes, and a modeling library. The executive code provides the interface between the engineering user and the application programs which perform the calculations requested by the user. The modeling library contains subroutines used to model the electromagnetic response of signal cables, power systems, and ground systems.

A modular approach is utilized in PRESTO to achieve maximum flexibility. The modularity of PRESTO and the independence of the executive control program make it a minor task to incorporate additional application codes and modeling libraries to perform system analysis other than for EMP analysis (e.g., radiation effects, structures, flight dynamics, hydraulics, and control systems). This capability to incorporate additional application codes and modeling libraries is discussed in more detail in Volume Two.

The PRESTO code interprets the user input, performs the required computation, and generates the output specified by the user. The PRESTO code processing flow for a typical run is shown in Figure 2.0-1. Section 2.1 presents an overview of the executive code, Section 2.2 presents an overview of the application codes, and Section 2.3 briefly describes the modeling library.

2.1 EXECUTIVE CODE

The PRESTO executive code consists of the control program ESCORT and ESCORT's data base. ESCORT is a general purpose control program designed to aid an engineer in running a set of independent application codes to perform an analysis. ESCORT provides the interface between the engineer and the application codes being used to accomplish a computation task. The user communicates with and directs the processing performed by ESCORT through user supplied inputs written in

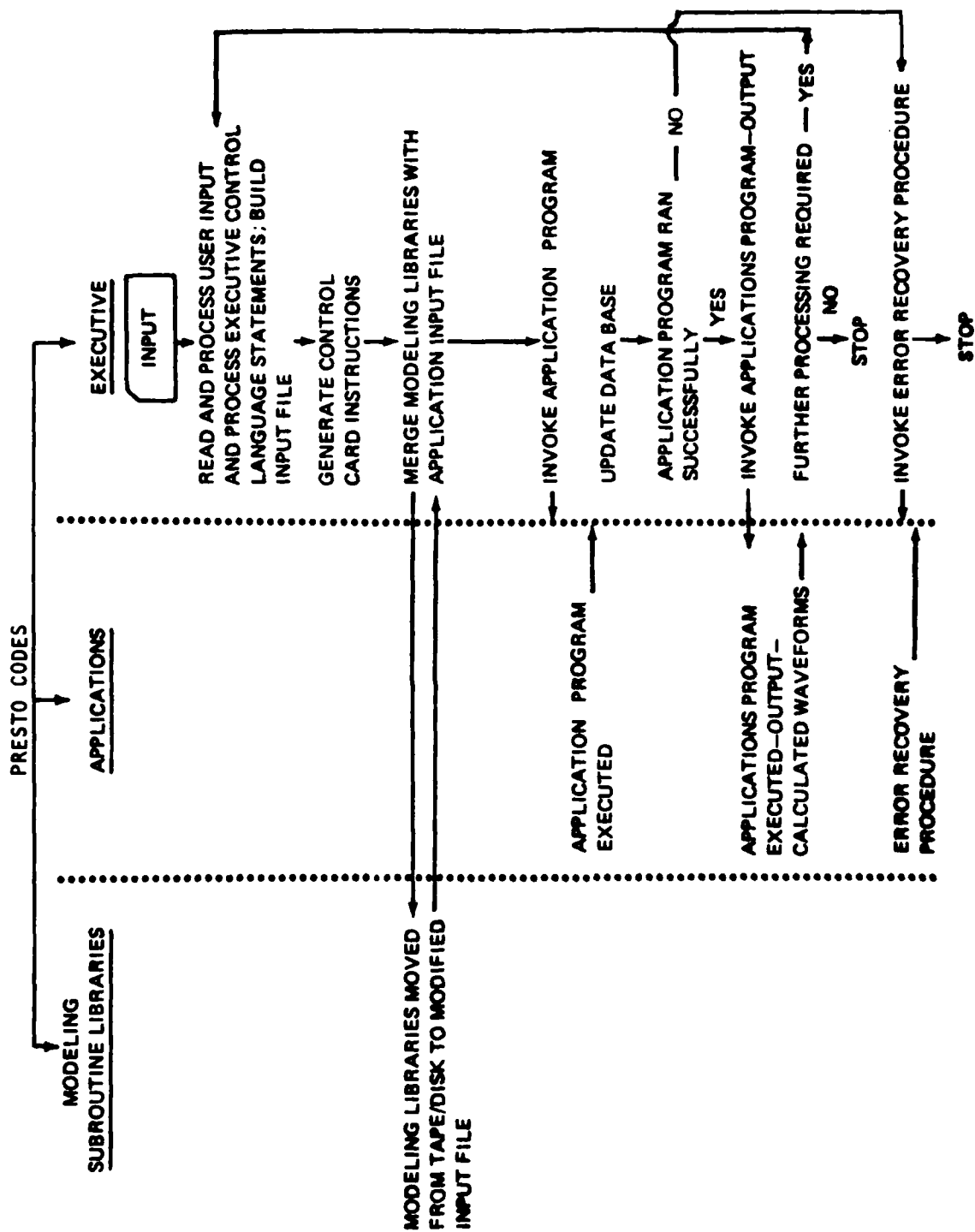


Figure 2.0-1. Example of PRESTO processing flow.

ESCORT Control Language (ECL). ECL aids the user in the generation of data for the application codes, the execution of the application codes on the computer, and the data flow between codes.

ESCORT and each of the application codes operate in the computer as a sequence of unique and independent steps. This permits, without modification, any existing computer code to be used at the appropriate step. The engineer, through the capabilities provided by ESCORT and its data base, is able to integrate the individual application codes into a unified system of codes to accomplish the desired task. ESCORT's data base is a collection of data available to all parts of the PRESTO code. Any part of the PRESTO code may use, modify, or determine a data element value in the data base through the capabilities provided by ESCORT.

The relationship between the user, executive control program, and the individual application codes is shown in Figure 2.1-1. The user prepares the input deck with the appropriate analysis control requirements using ECL. The ECL then provides the interface between the application codes and ESCORT data base. The output is then provided to the user in the desired format, i.e., printer plots and computer reports.

The User's Guide for ESCORT is presented in Volume Two.

2.2 APPLICATION CODES

The PRESTO application codes are invoked by ESCORT to perform the analysis requested by the user. The various application code modules which are included in PRESTO are shown in Figure 2.1-1. The remainder of this section discusses each application code in the PRESTO system.

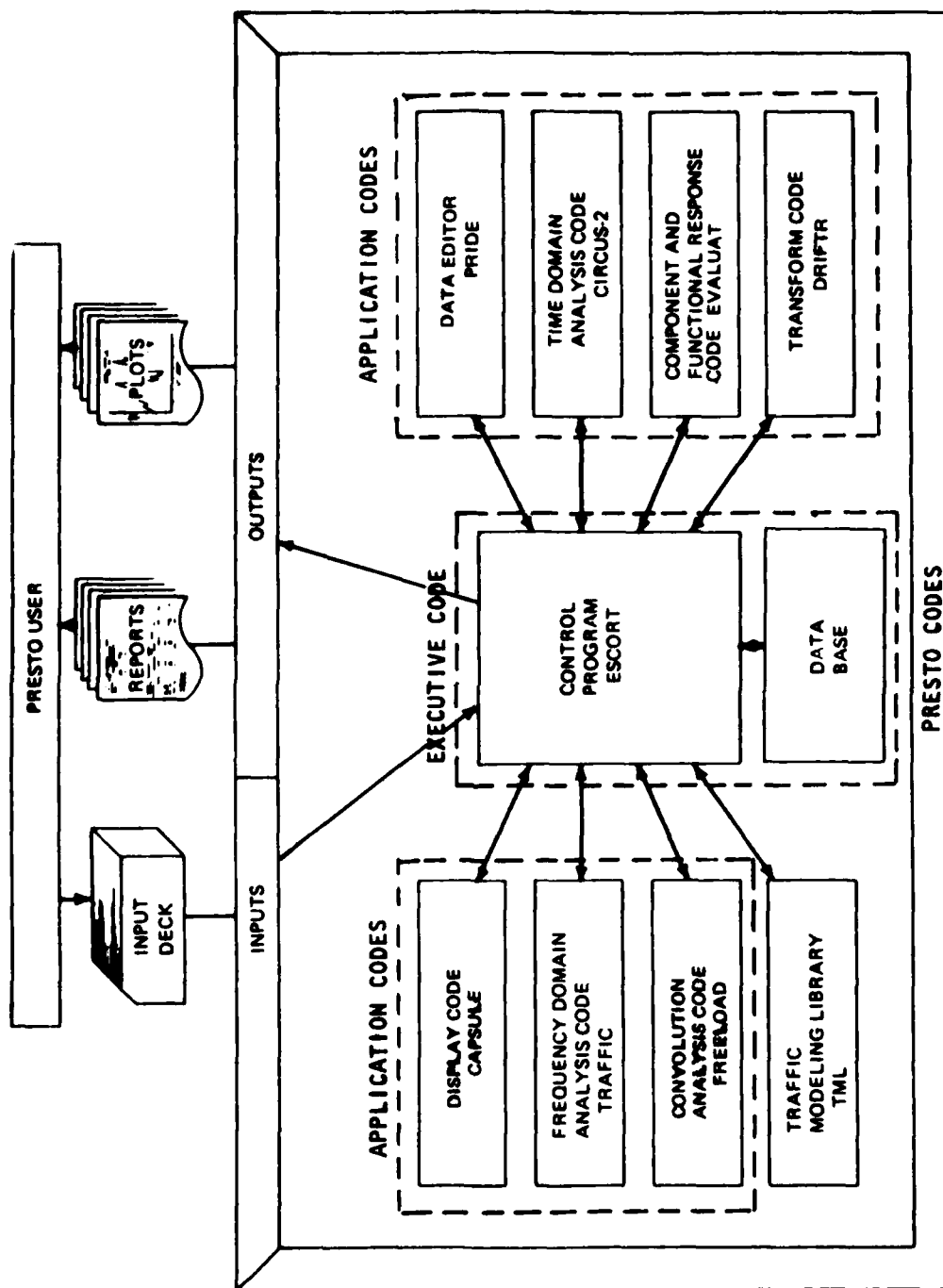


Figure 2.1-1. Interrelation of PRESTO codes.

A

2.2.1 Frequency Domain Network Analysis Code - TRAFFIC

TRAFFIC provides the capability to perform frequency domain analysis of electrical networks. A major emphasis in TRAFFIC code development has been on efficient simulation of very large electrical networks. Input data include 1) networks of lumped RLCM (resistor, inductor, capacitor, mutual inductor) elements; 2) networks of distributed RLCM elements; 3) numerical admittances with or without associated Norton currents (defined by user written modeling subroutines); and 4) magnetic tape files containing (a) Norton equivalent circuits, and (b) numerical voltages and currents.

The output from TRAFFIC includes 1) magnetic tape files containing Norton equivalent circuit and system function values and 2) printed tabular values and plots of system functions (magnitude and phase) which include node voltages, branch currents, transfer functions, and driving point functions.

TRAFFIC employs state-of-the-art numerical methods including full exploitation of sparse matrix techniques for efficiently solving large network problems. Error monitoring capabilities provide a verification of numerical accuracy, thereby aiding in the validation of results.

The TRAFFIC User's Guide is presented in Volume Three.

2.2.2 Time Domain Network Analysis Program - CIRCUS-2

CIRCUS-2 provides the capability to perform time domain analysis of electrical networks. Input data include values for resistors, capacitors, and inductors, convolution kernels (tabular admittance values versus time), nonlinear elements (i.e., diodes, semiconductor models), voltage sources, and current sources. The input data may be fixed-value or their values may be mathematical functions of the voltages across, and the currents through, circuit elements.

CIRCUS-2 is used to determine circuit upset and damage thresholds in an EMP environment. CIRCUS-2 employs state-of-the-art techniques in numerical integration and sparse matrix methods. The integration method is a numerically stable method currently in use and provides precise error control to assure accurate results. Sparse matrix techniques allow flexibility in modeling and solving large networks.

The User's Guide for CIRCUS-2 is presented in Volume Four.

2.2.3 PRESTO Input/Output Data Editor (PRIDE)

The PRESTO data editor, PRIDE, provides a general data editing capability for data generated by other PRESTO application codes as well as for data obtained from other sources (e.g., test data).

PRIDE is capable of merging data sets, extracting data to make a subset, replacing erroneous data values, interpolating data, and scaling independent and dependent variables. PRIDE also edits names, titles, and miscellaneous data associated with a data set. PRIDE contains an algebraic processing language for adding, subtracting, multiplying and dividing data sets. User supplied subroutines to generate or manipulate data can also be linked with PRIDE.

The User's Guide for PRIDE is presented in Volume Five, Part One.

A

2.2.4 Direct and Inverse Fourier Transform Code (DRIFTR)

The PRESTO Fourier transform code, DRIFTR, provides the capability to perform direct and inverse Fourier transforms using several different techniques, from direct integrating routines to FFT's. DRIFTR will automatically select the optimum technique for performing the desired transform based on the spacing of the input and output waveform data.

The User's Guide for DRIFTR is presented in Volume Five, Part One.

A

2.2.5 Display Code - CAPSULE

The PRESTO display code, CAPSULE, provides a generalized plotting capability. CAPSULE provides numerous routines for obtaining displays of time and frequency domain data in many user-desired formats. These displays are accompanied by labels and explanatory text provided by CAPSULE and/or by user specification.

The User's Guide for CAPSULE is presented in Volume Five, Part One.

A

2.2.6 Component Threshold/Response Comparison - EVALUAT

The EVALUAT code is used to compare the predicted time domain signal induced at a component with a component upset and damage threshold to make statistical probability of failure predictions. The component probabilities of failure and the functional response model are used to define probabilities of functional responses for a facility under analysis.

A

The User's Guide for EVALUAT is presented in Volume Five, Part Three.

A

2.2.7 Convolution Analysis Code - FREELoad

The FREELoad code provides the capability to convert frequency domain Norton equivalent circuits into a form acceptable for time domain analysis. This capability is provided by the method of characteristics which is similar to the method of convolution integrals. The inputs to FREELoad are the Norton equivalent circuits; the outputs of FREELoad are inputs to the CIRCUS code.

The User's Guide for FREELoad is presented in Volume Five, Part Two.

A

2.3 TRAFFIC MODELING LIBRARY (TML)

The TRAFFIC modeling library contains subroutines which can be used to model the electromagnetic environment, penetrations, and electromagnetic coupling paths used by the circuit analysis code TRAFFIC during the calculation of responses of signal cables, power systems, and ground systems.

The Modeling Library User's Guide is presented in Volume Six.

3.0 PRESTO CODE NUMERICAL ACCURACY

There are two primary sources of error in using the PRESTO code to solve mathematical problems. The first is due to an incapability to formulate the problem in terms of mathematical expressions; the second results from the errors associated with approximation of the solution to a mathematical expression using a digital computer code. It is the approximation error that will be discussed in this section. Approximation error occurs when a mathematical problem cannot be solved exactly and a numerical approximation to the solution is used. Quantization error occurs when an analytic function is represented by a set of discrete values. Round-off error occurs because the computer expresses arithmetic operations with limited precision (for PRESTO on the CDC 6600, at least eight significant figures can be expected).

The PRESTO codes that only sort and format data have no numerical errors. ESCORT (executive) and CAPSULE (display) are examples of such codes.

The codes which are subject to one or more of the above numerical errors include TRAFFIC, DRIFTR, EVALUAT, and CIRCUS-2.

The frequency domain analysis program, TRAFFIC, has only quantization and round-off errors. The quantization error is a result of the accuracy with which TRAFFIC reproduces a spectrum of a system function. TRAFFIC will compute the value of the spectrum at intervals of Δf up to a given maximum frequency f_{\max} .

If the spectrum changes significantly in a Δf interval or has significant content at frequencies above f_{\max} , the TRAFFIC output results will be misleading. The quantization error can be minimized by changing the intervals of Δf and maximum frequency f_{\max} and observing when there is no change in the response. On typical problems a 5% error may be expected.

EVALUAT uses fast Fourier transforms of known probability density functions, allowing Δf and N to be chosen to produce any desired accuracy. In EVALUAT, Δf and N are chosen to produce errors of less than 10^{-5} in the computed probabilities.

A
A

The primary function of CIRCUS-2 is to solve the ordinary differential equations associated with the circuit being analyzed. The accuracy of the solution method is determined by user input, but it is usually set to a relative error of 0.1%. If the circuit equations are smooth, the computed results will be within 0.1% of the true solution to the equations. For circuits with sharp discontinuities, results will not be this accurate.

A secondary function of CIRCUS-2 is to solve the integral equations associated with FREELoad (method of characteristics) models. The methods used are not accuracy controlled as in the ordinary differential equations, but they are restricted to a minimum step that is determined by the highest frequency of the data. For this reason, the accuracy of the results of the solutions is determined by the frequency range of the input and is comparable to the accuracy of the Fourier analysis routines.

4.0 PROBLEM SIZE CAPABILITY

The size of the problem that PRESTO is capable of solving is a function of the type of the analysis to be performed. The following are variables which impact this capability:

- 1) The number, size, and complexity of the submodels which make up the model,
- 2) The number of responses desired, and
- 3) The individual machine limitations.

A single run has routinely handled electrical models described by electromagnetic circuits with thousands of nodes and consisting of hundreds of submodels of racks and cables.

A

5.0 PRESTO INPUT

PRESTO input consists of 1) analysis controls and 2) a problem definition. Analysis controls involve two types of user instructions; those required by the executive code and those required by the individual application codes. The analysis controls for the executive code provide the user with the capability to dynamically specify the execution sequence of the application codes and to transfer data between application codes. The analysis controls for the individual application codes define the types of analyses the codes must perform, the input data required, the analysis and data processing options, and the desired output data. The problem definition consists of the description of the EMP environment and the physical parameters of the communications facility. The environment description consists of the parameters necessary to define the electromagnetic energy incident on the facility. The physical parameters are a definition of the electrical properties and geometrical configuration of the facility. In particular, the physical parameters describe the predominant electromagnetic coupling paths and critical components within the facility. In addition, the physical parameters include a specification of the particular modeling subroutines to be used. The problem definition becomes the input data for the individual application codes.

The structure of a typical PRESTO deck is shown in Figure 5.0-1. This deck structure could be used to perform a frequency domain analysis of the electromagnetic coupling from an EMP to a facility's critical circuits using TRAFFIC, followed by transformation of the frequency domain results to the time domain using DRIFTR. The deck starts with a control card record. Following the control card record, the PRESTO deck contains alternate blocks of executive code data and application codes (TRAFFIC and DRIFTR) data. The executive code data blocks consist exclusively of analysis controls for the executive code (ESCORT). The application code data blocks consist of both analysis controls and input data. The input data consists of the portion of the problem definition relevant to the particular application code.

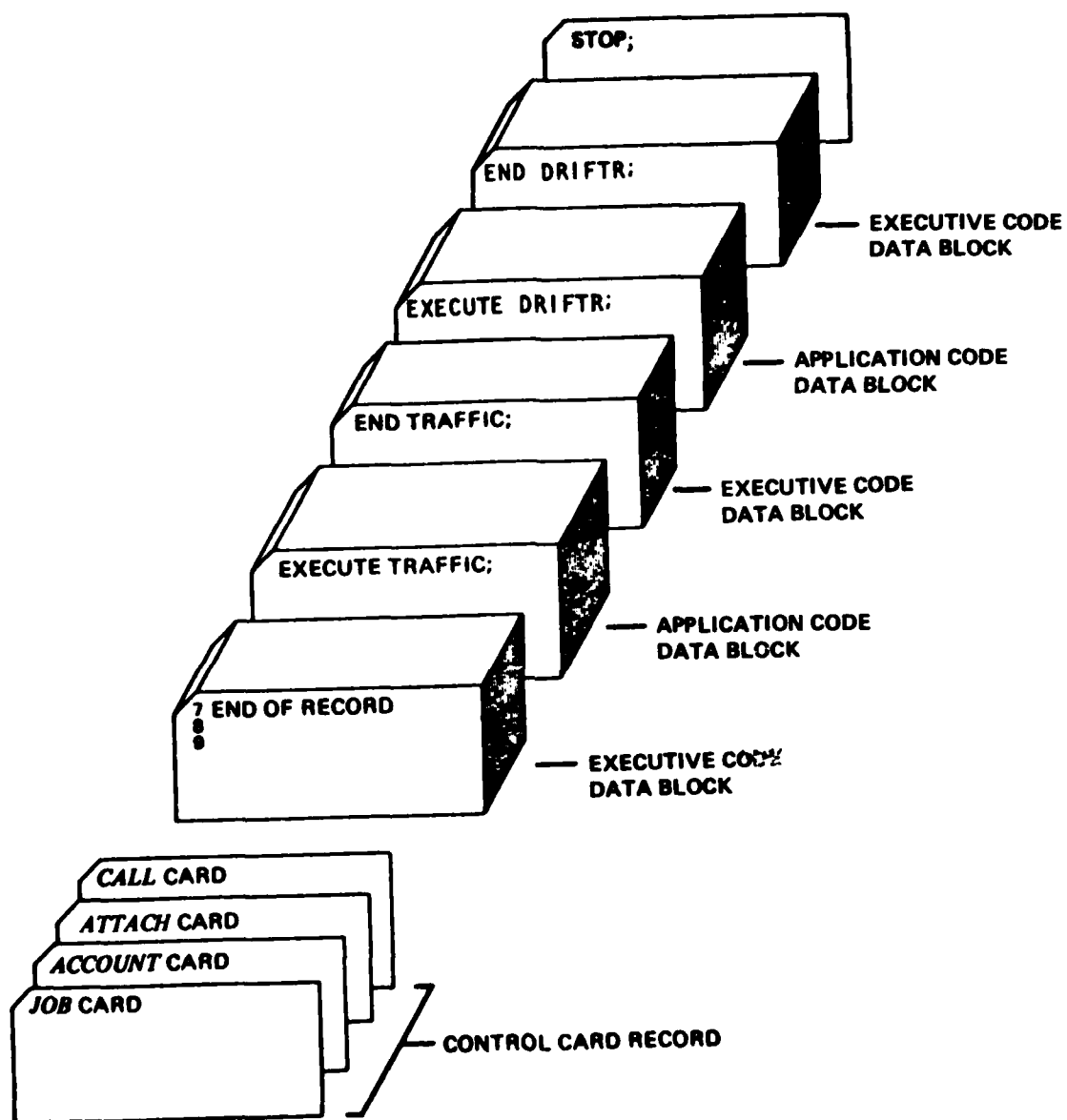


Figure 5.0-1. Typical PRESTO data deck structure.

6.0 PRESTO OUTPUT

PRESTO generates three types of output. The first type of output consists of two-dimensional plots and tabulated listings of time domain waveforms and frequency domain spectra. The second type consists of statistical prediction of component and functional responses of a facility. The third type consists of parameters placed in the data base by the application codes. These parameters can be tested to control the sequencing of the application codes or printed out in a user-generated report format.

A

7.0 CONCLUSIONS

The PRESTO code has been developed for the analysis of electronic circuits in an EMP environment. It includes codes (modeling library) for modeling the electromagnetic response of equipment in an EMP environment, codes (application codes) for performing the computational analysis requested by the user and an executive code providing the interface between engineering user and the application codes.

A modular approach was used in developing PRESTO. The modular approach allows additional system analysis, other than EMP analysis (e.g., radiation, blast, thermal, shock, structures ...), to be incorporated in PRESTO with a relatively small effort.

A

DISTRIBUTION LIST

DEPARTMENT OF DEFENSE

Assistant Secretary of Defense
Comm, Cmd, Cont & Intell
ATTN: Surveillance & Warning Sys
ATTN: Programs & Resources
ATTN: Assistant Director (Sys)
ATTN: Telecomm Systems

Commander in Chief, Pacific
5 cy ATTN: C3SRD

Defense Communications Agency
ATTN: Code 101B
ATTN: WWMCCS Sys Engr

Defense Communications Agency, Pacific Area
ATTN: Commander

Defense Communications Engineer Center
ATTN: Code R720, C. Stansberry

Defense Intelligence Agency
ATTN: DT

Defense Nuclear Agency
ATTN: RAAE
ATTN: NATA
ATTN: RAEE
4 cy ATTN: TITL

Defense Technical Information Center
12 cy ATTN: DD

Field Command
Defense Nuclear Agency
ATTN: FCPR, J. T. McDaniel

Field Command
Defense Nuclear Agency
Livermore Branch
ATTN: FCPRL

Joint Chiefs of Staff
ATTN: J-5 Nuclear Division
ATTN: C3S Evaluation Office
ATTN: J-3 WWMCCS & Telecommunications
ATTN: SAGA

Joint Strategic Connectivity Staff
ATTN: JCC, A. Buckles

Joint Tactical Communications Ofc
ATTN: TT-E-SS

National Central Security Svc, Pacific Area
ATTN: Central Sec Svc, Pac Area

National Communications System
ATTN: NCS-TS

National Security Agency
ATTN: R52
ATTN: S-15

DEPARTMENT OF DEFENSE (Continued)

Net Assessment
Office of the Secretary of Defense
ATTN: Military Assistants

U.S. National Military Representative
SHAPE
ATTN: Surv Sect, E. Royer

Under Secy of Def for Rsch & Engrg
Department of Defense
ATTN: Strategic & Space Sys (OS)
ATTN: DEPUNSEC C3I—Strategic & C2 Sys
ATTN: DEPUNSEC Com Sys

DEPARTMENT OF THE ARMY

Dep Ch of Staff for Rsch Dev & Acq
Department of the Army
ATTN: DAMA-CSS-N

Department of the Army
ATTN: DAMO-TCV-A

Harry Diamond Laboratories
Department of the Army
ATTN: 21500
ATTN: Chief Div 10000
ATTN: Chief Div 20000
ATTN: Chief Div 30000
ATTN: Chief Div 40000
ATTN: Chief Div 50000
ATTN: HDL Library 811000
ATTN: DRDEL-OT
ATTN: HDL Library (Woodbridge) 811000
ATTN: 00100 Commander/Tech Dir/TSO
2 cy ATTN: Chief 21000
2 cy ATTN: Chief 22000
3 cy ATTN: Chief 20240

Multi Service Communications Systems
Department of the Army
ATTN: DRCPM-MSCS-APB, M. Francis

U.S. Army Communications Command
ATTN: CC-OPS-WR

U.S. Army Communications Sys Agency
ATTN: CCM-AD-LB
ATTN: CCM-RD-T
ATTN: CCM-AD-SV

U.S. Army Computer Systems Command
ATTN: Technical Library

U.S. Army Materiel Dev & Readiness Cmd
ATTN: DRXAM-TL

U.S. Army Nuclear & Chemical Agency
ATTN: Library

U.S. Army Western Command
ATTN: Communications Electronics Div

DEPARTMENT OF THE NAVY

Naval Electronic Systems Command
ATTN: PME 117-20
ATTN: Technical Library

Naval Material Command
ATTN: C8DE1, N. Jackson

Naval Ocean Systems Center
ATTN: Code 4471

Naval Postgraduate School
ATTN: Code 1424, Library

Naval Research Laboratory
ATTN: Code 2627

Naval Sea Systems Command
ATTN: SEA-6431

Naval Security Group Command
ATTN: G83

Naval Shore Electronics Engineering
ATTN: D. Koide

Naval Surface Weapons Center
ATTN: Code F32
ATTN: Code F30

Naval Telecommunications Command
ATTN: Deputy Director Systems

NAVCAMS EASTPAC
Department of the Navy
ATTN: Commander

NAVCAMS WESTPAC
Department of the Navy
ATTN: Commander

Office of the Chief of Naval Operations
ATTN: OP 98
ATTN: OP 94

Strategic Systems Project Office
Department of the Navy
ATTN: NSP-43

U.S. Pacific Fleet
Department of the Navy
ATTN: Commander

DEPARTMENT OF THE AIR FORCE

Air Force Communications Service
ATTN: XP

Air Force Electronic Warfare
ATTN: XRX

Air Force Office of Scientific Rsch
ATTN: J. Allen

Air Force Weapons Laboratory
Air Force Systems Command
ATTN: SUL

Air University Library
Department of the Air Force
ATTN: AUL-LSE

DEPARTMENT OF THE AIR FORCE (Continued)

Assistant Chief of Staff
Studies & Analyses
Department of the Air Force
ATTN: AF/SA

Deputy Chief of Staff
Operations Plans and Readiness
Department of the Air Force
ATTN: AFXOK

Deputy Chief of Staff
Research, Development, & Acq
Department of the Air Force
ATTN: AFRDS

Foreign Technology Division
Air Force Systems Command
ATTN: NIIS Library

Commander in Chief
Pacific Air Forces
Department of the Air Force
ATTN: Communications Electronics

Pacific Communications Area (AFCS)
Department of the Air Force
ATTN: Comm Electronics Eng

Rome Air Development Center
Air Force Systems Command
ATTN: TSLD

Strategic Air Command
Department of the Air Force
ATTN: XPFS
ATTN: NRI-STINFO Library

Hq United States Air Force
ATTN: SASM

OTHER GOVERNMENT AGENCIES

Central Intelligence Agency
ATTN: OSR/SE/C

Federal Emergency Management Agency
ATTN: Plans & Operations (EO)

DEPARTMENT OF DEFENSE CONTRACTORS

American Telephone & Telegraph Co
ATTN: Sec Ofc for W. Edwards

BDM Corp
ATTN: L. Jacobs
ATTN: W. Sweeney

Boeing Co
ATTN: B. Gage
ATTN: R. Scheppe
ATTN: V. Jones

Booz-Allen & Hamilton, Inc
ATTN: D. Durgin

EG&G Washington Analytical Svcs Ctr, Inc
ATTN: A. Bonham

Boeing Co
4 cy ATTN: V & H Engineering Staff

DEPARTMENT OF DEFENSE CONTRACTORS (Continued)

General Dynamics Corp
ATTN: B. Wallace

Georgia Institute of Technology
ATTN: Res & Sec Coord for H. Denny

Grumman Aerospace Corp
ATTN: A. Zimbalotti

Institute for Defense Analyses
ATTN: Classified Library

IRT Corp
ATTN: B. Williams

Kaman Tempo
ATTN: DASIAC

McDonnell Douglas Corp
ATTN: C. Fisher

ORI, Inc
ATTN: R. Henderson

Pacific-Sierra Research Corp
ATTN: H. Brode

R & D Associates
ATTN: W. Graham
ATTN: P. Haas

DEPARTMENT OF DEFENSE CONTRACTORS (Continued)

McDonnell Douglas Corp
ATTN: Tech Library C1-250, 36/84 ADTL 581-81

R & D Associates
ATTN: J. Bombardt

Rockwell International Corp
ATTN: G. Morgan

SRI International
ATTN: E. Vance
ATTN: A. Whitson

Sylvania Systems Group
Communication Systems Division
ATTN: R. Steinhoff

Sylvania Systems Group
Electronics Systems & Services Organization
ATTN: E. Motchok
ATTN: A. Novenski

TRW Defense & Space Sys Group
ATTN: J. Brossier

TRW Defense & Space Sys Group
ATTN: Librarian

Vought Corp
ATTN: B. Morris

ACTIVE SHEET RECORD

SHEET NO.	REV LTR	ADDED SHEETS				SHEET NO.	REV LTR	ADDED SHEETS			
		SHEET NO.	REV LTR	SHEET NO.	REV LTR			SHEET NO.	REV LTR	SHEET NO.	REV LTR
1	A										
2	A										
3	A										
4	A										
5	A										
6	A										
7	A										
8	A										
9	A										
10	A										
11	A										
12	A										
13	A										
14	A										
15	A										
16	A										
17	A										
18	A										
19	A										
20	A										
21	A										
22	A										
23	A										
24	A										
25	A										
31	A										
32	A										

SIZE
A

CODE IDENT NO.
81205

SCALE

REV **A**

SHEET **31**

J18-047

REVISIONS			
REV SYM	DESCRIPTION	DATE	APPROVAL
A	Corrected errors and rewrote unclear areas. Revised pages 1-5, 7-10, 12, 14, 16, 17, 20, 21 and 23-25. Added pages 31 and 32.	10/31/80	

D1 4100 7720 ORIG. 3/71

REV SYM A

~~BOEING~~

NO.

PAGE 32



